ASPIRES 2

Executive Summary

Young people's science and career aspirations, age 10–19

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Understanding and improving STEM participation – the ASPIRES 2 study

Participation in STEM (Science, Technology, Engineering and Mathematics) is widely recognised as being highly important for national economic competitiveness, greater upward social mobility and active citizenship. There is a strongly-held belief that our future society and workforce will need more, and more diverse, young people continuing with STEM post-16. Increasing and diversifying participation in STEM is a pressing concern for policy-makers, practitioners and researchers across the globe. Moreover, despite longstanding investments of time and resource in attracting more young people, patterns in STEM participation in post-compulsory schooling remain stubbornly resistant to change.

The ASPIRES 2 research sought to generate new understandings of how and why young people come to see science as being 'for me', or not, with the goal of informing policy and practice to support increased and more equitable participation in STEM.

ASPIRES 2 is a large, national mixed-methods project which investigated young people's science and career aspirations from ages 14 to 19. The study extended previous research conducted with the same cohort of young people, who took part in the first ASPIRES project at ages 10 to 14. ASPIRES 2 provides an authoritative and valuable source of evidence as to how young people view science (and STEM) and how these views change over time, offering insights into key factors that influence their views and aspirations. In particular, it provides fresh insights into factors shaping young people's STEM participation and why existing participation patterns are so resistant to change.

The study explored:

- What shapes young people's desire to continue with science qualifications and career ambitions after compulsory education (science aspirations)?
- What are the factors that influence how young people identify as being 'good at science' and/or being 'science-y' (science identities)?

The study offers new understanding on the interplay between personal, social, familial, institutional and structural factors, alongside practices that influence young people's potential to engage and continue with science. While the study's primary focus is on the three core school science subjects, the report also summarises findings relating to technology, engineering and mathematics.

Methods

The ASPIRES and ASPIRES 2 projects tracked a cohort of young people in England from age 10 to 19 (2009 – 2018), through over 40,000 surveys and 660 in-depth interviews with young people and parents/ carers. Data were collected from the cohort at five time points (when the young people were in school years 6, 8, 9, 11 and 13, at ages 10/11, 12/13, 13/14, 15/16 and 17/18, respectively). Follow-up interviews were also conducted at age 19.

Findings

Young people's career aspirations are relatively stable over time

- Patterns of aspiration are relatively consistent from age 10 to 18. Most students' job aspirations persisted over time (e.g. 'arts-related' aspirations).
- There was no evidence of a poverty of aspiration. The majority of young people aspired to university and professional careers, irrespective of their backgrounds. Figure 1 below presents a summary of student aspirations from age 10-18.
- There was no evidence that a lack of aspiration among young people is driving recruitment shortages in areas such as teaching. For example, over a third of secondary school students in our sample aspired to join the teaching profession – a sector which has failed to meet recruitment targets in recent years.[i]
- The proportion of young people specifically aspiring to be a scientist is around 16% (see Figure 2), is established fairly early and remains stable from age 10 to 18. However, as noted below, the demographic profile of *who* expresses these science aspirations becomes less diverse over time.

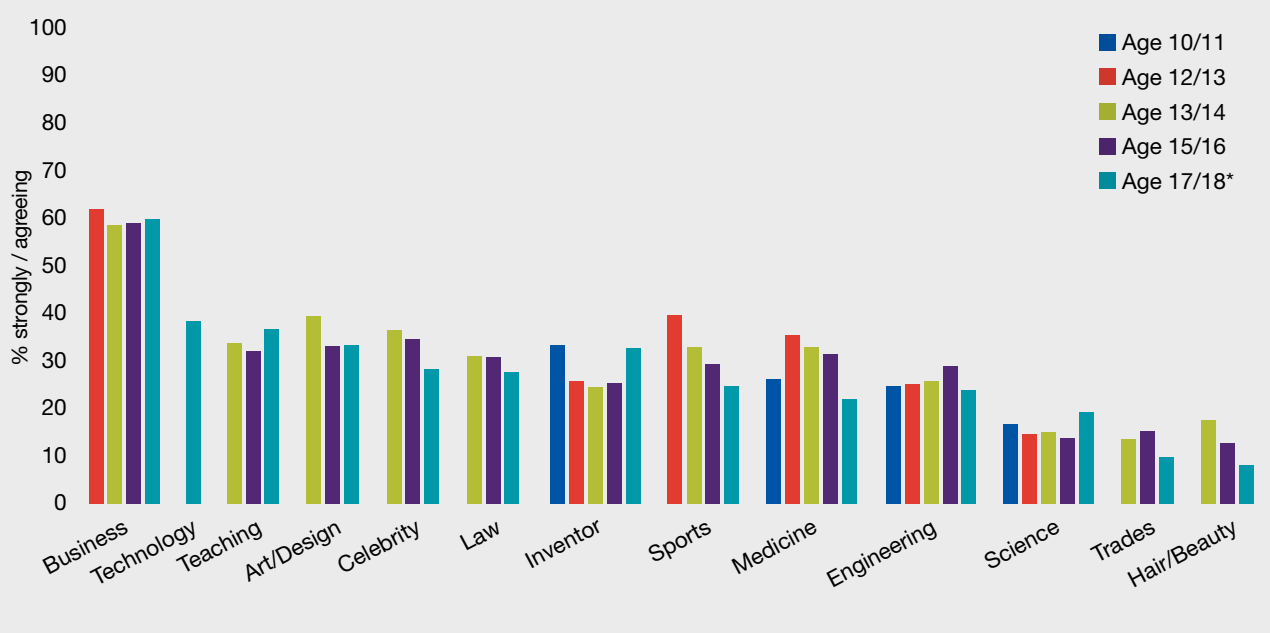


Figure 1. A summary of young people's career aspirations by age – survey data from over 40,000 students aged 10-18.
Note: *The data from students aged 17/18 is weighted to national A Level science entries.

Persistent, low science aspirations are not due to lack of interest in science

- ASPIRES 2 further confirmed the findings of the original ASPIRES study that low levels of science aspiration were not a consequence of a low interest in science, a lack of family support or the effect of negative views about scientists – see Figure 2 on the following page.

Science aspirations and science identity age 10-19 show patterns of inequalities

- Inequalities in science identities and aspirations were evident in primary school and exacerbated through secondary school. High achieving, middle-class students identifying as male and students with high levels of family science capital were much more likely to aspire to a career in science and to feel, and be recognised by others as being, 'science-y'.

i Foster, D. (2018). *Teacher recruitment and retention in England*. House of Commons Briefing Paper Number 7222. London, House of Commons Library.

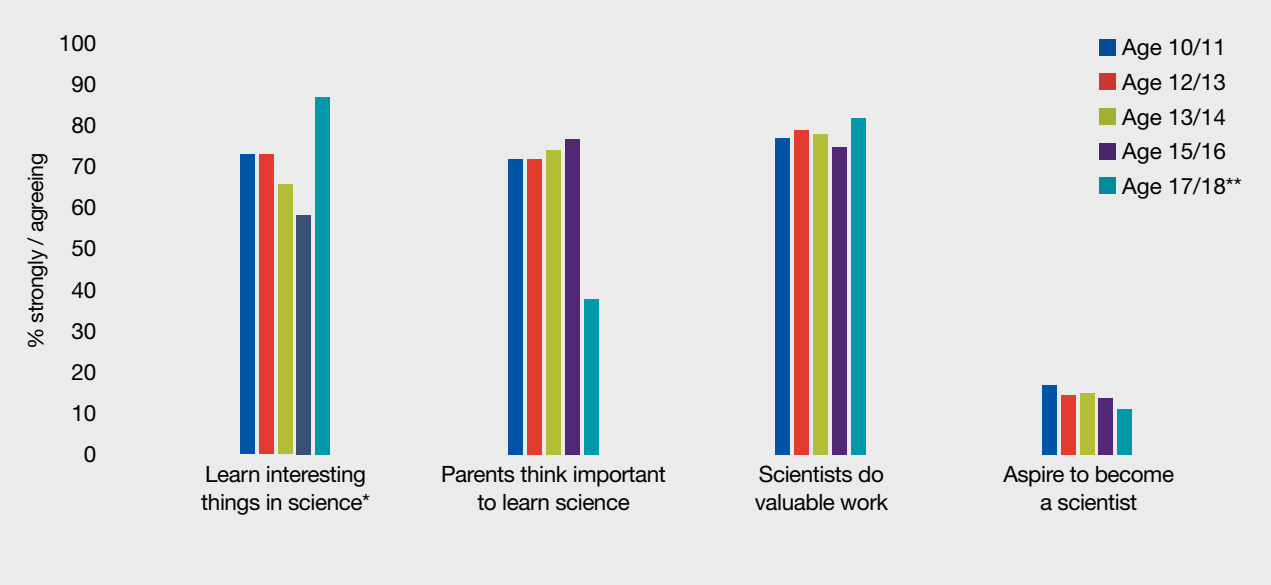


Figure 2. A summary of young people's science interest, perceptions and aspirations by age – survey data from over 40,000 students aged 10-18. ***Note:*** *Only asked of students aged 17/18 studying at least one science A Level. **The data from students aged 17/18 is weighted to national A Level science entries.

- Students identifying as Black expressed high levels of science aspiration and science self-concept, yet these do not seem to translate into post-16 science participation and/or intentions towards science careers. We discuss this disjuncture as arising from racism and other social inequalities, which we refer to as the 'science debt' that is owed to these students by society.

Factors shaping science aspirations and identities

ASPIRES 2 has enabled us to identify several key factors that shape young people's science identities and aspirations. We found that these factors are very heavily influenced by existing social inequalities such as class, gender and ethnicity, and by whether a young person has had opportunities to experience, do well in, feel connected with, be recognised in, and continue with STEM.

The factors influencing young people's science identities and aspirations are complex and multiple. They can be grouped into three overarching themes: capital-related inequalities; dominant representations of science and educational factors and practices.

The model presented in Figure 3 on the following page is a representation of these factors, and shows how there is no one single influence on science aspirations. Instead, a multitude of inequalities and experiences interact to either support or constrain a young person's science identity and/or aspiration.

We conceptualise social class, gender and ethnicity as socially constructed identities/inequalities. Social class was attributed using a proxy measure of cultural capital. This report uses participants' self-reported gender (e.g. where the text says 'young women'/'female/'girls' it refers to those who self-identified as female). Some participants self-identified as non-binary and this is noted where applicable. Ethnicity for the purposes of our work relates to students' self-reported identities within the following categories; Black (Caribbean, African), South Asian (Indian, Pakistani, Bangladeshi), Chinese or East Asian (Chinese, Japanese, Korean), White (British), Middle Eastern, Other (Mixed Black and White, Asian and White, Asian and Black). Within each of the ethnicity subgroups students were also able to select and specify Other and Prefer not to say.

'Capital', as proposed by the sociologist Pierre Bourdieu, refers to a person's resources, experiences or assets.[ii] We developed the concept of **science capital** during the first phase of the ASPIRES study as a way of encapsulating all the science-related knowledge, attitudes, experiences and social contacts that an individual may have. The concept of science capital helps us to understand why some people engage with science and others do not. For more information visit: **www.ucl.ac.uk/ioe-sciencecapital**

ii Bourdieu, P. (1984). *Distinction*. Cambridge, MA, Harvard University Press.

Figure 3. A model of factors shaping young people's science identities and aspirations age 10-19.

1. Capital-related inequalities

- Our research showed that how much, and what type, of capital a young person has (and continues to acquire throughout their education) will feed into how likely they are to pursue science and/or feel confident about their abilities in science.
- Students with lower levels of science capital were less likely to aspire to continue with science. For instance, of our longitudinally tracked students, 80% of those who had 'never' aspired to science had 'low' science capital. By contrast, 83% of those who continued with science post-18 had 'high' science capital.

We use the terms 'low' and 'high' with caution, as provisional, accessible terms for the academic concepts of exchange-value and use-value capital, while recognising that important nuance is lost in translation and that the terms can unhelpfully reify and lend to unintended deficit interpretations of capital.

2. Dominant educational and social representations of science

- We found that how science is represented (e.g. through science education, the media and in everyday life) can be very influential in shaping whether young people go on to form science aspirations or consider themselves 'suited' to science.
- The pervasive dominant association with 'cleverness' and 'masculinity' is detrimental and makes many young people feel that science is 'not for me'.
- Even very high attaining students, but particularly young women, worried that they might not be 'clever enough' to continue with science, but particularly physics.
- Over time, many young women who continued with physics progressively 'downplayed' their femininity in order to better fit the masculine image and culture of the subject.

3. Educational factors and practices

- Our data showed that teachers' attitudes and behaviours, young people's experiences of school science, and the nature of the curriculum all play a part in reinforcing or undermining science aspirations and identities.
- Young people's science choices, aspirations and progression were channelled and constrained by a range of educational gatekeeping practices, most notably through the stratification of science routes at Key Stage 4[iii] (into 'Double' and 'Triple'[iv] routes) and through stringent grade entry requirements for science A levels.
- The most socio-economically disadvantaged students were two and a half times less likely to study Triple Science compared to the most advantaged.
- Teacher specialism, supply and retention impacted on students' likelihood of identifying with and aspiring to science although these issues impacted particularly on working-class and minority ethnic students, who reported the most teacher turnover and teaching quality issues.
- Boys and students with high cultural capital were the most likely to report receiving support and encouragement from their teachers to achieve well in, and to continue with, science.
- Less than two-thirds (63%) of students aged 15-16 reported having received any careers education and only half had undertaken work experience. We found that careers education provision was patterned by social inequalities, with working-class, minority ethnic students, girls and lower-attaining students being significantly less likely to receive and benefit from high quality careers support.

Discipline-specific issues

In addition to looking at general science aspirations and identities we analysed the impact of these key factors on young people's identities and aspirations in relation to **physics, chemistry and biology**. We found that these factors had different degrees of influence in relation to each science. For example, we found that:

- Physics imposed the strictest educational gatekeeping practices of all the sciences. Students who did not achieve the top GCSE grades described being barred from embarking on a **physics** A Level courses.
- Students taking **chemistry** A Level had the highest levels of science capital (including those taking physics and biology).
- In **biology**, gender was found to be one of the biggest influences (biology A Level students were three times more likely to be female than physics students, and one and a half times more likely to be female than chemistry students).

Beyond science – young people's view of engineering, technology and maths

For the first time, ASPIRES 2 data allowed us to consider how the different areas of STEM relate, and are influenced by external factors. For example, we found that:

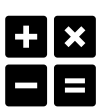
- Science capital can be used as a partial proxy for 'STEM capital' - a student with high levels of science capital was significantly more likely to express positive attitudes towards all four STEM disciplines and was more likely to aspire to pursue a degree in science or engineering.

iii Key Stage 4 (KS4) is the stage of school education in England that incorporates national GCSEs examinations, over Years 10 and 11, and sometimes Year 9.

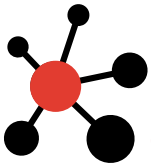
iv 'Triple Science' is the study of three separate science GCSEs, whereas students studying 'Double Science' (or Combined Science) study all three sciences for two GCSE awards. Students then have the option to study multiple routes including; A level (considered the prestigious route to university entrance), AS level, BTEC (more applied training route) and International Baccalaureate.

- Gender plays a very strong role in technology, engineering and maths aspirations and identities. For example, fewer girls than boys agreed that a **technology** qualification can help you get a wide range of jobs. Girls were also much less likely than boys to aspire to careers in technology and reported less parental support to continue with technology.
- Gender had a very large effect on **engineering** aspirations that was evident from the age of ten. For instance, only 11% of girls aged 10 aspired to engineering careers, compared to 44% of boys.
- Compared to their peers, students who aspired to **engineering** expressed distinctive views, being more likely to be motivated to earn a lot of money, make a difference in the world and to create things. Young women who aspired to engineering were highly distinctive (compared to both young women in general and young men who aspired to engineering), being exceptionally confident in their science academic abilities and relatively less likely to be motivated by a desire to help other people through their future careers.

- **Mathematics** was one of the consistently popular (liked) subjects throughout school from age 10-18, although the percentage of students intending to study maths post-16 declined as students progressed through secondary school. The majority of students (68%) agreed that maths is relevant and useful for their everyday life, although this percentage was lower than for science (80%). The students least likely to express high self-confidence in maths were young women.



68%



80%

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Recommendations

What do our findings means for policy and practice?

We suggest that STEM education policy and practice communities might usefully consider changes to how we think about STEM engagement and inspiration work and changes to what we do in practice (see Figure 4 below).

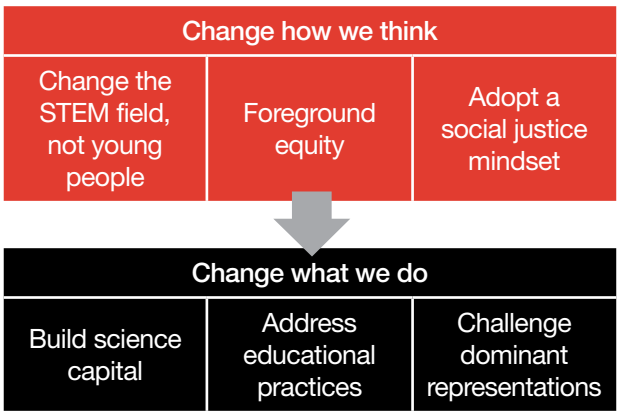

Figure 4. Overview of recommendations for policy and practice.

Changing how we think

- **Focus on changing STEM education, not young people.** The sector needs to recognise, and challenge the processes that maintain and perpetuate the elitism of STEM, which underpin and drive low and unequal participation. Widening participation in STEM requires changes in power relations and cannot be achieved by continuing with 'business as usual'.
- **Foreground equity in all STEM education policy and practice.** Acknowledging how social inequality drives aspirations and self-identity in science; equity and social justice should be placed at the heart of STEM education. Where equity is not foregrounded, the default will be the reproduction of inequalities.
- **Employ a social justice mindset.** Applying a social justice framework to STEM education policy and practice can support more equitable and informed approaches to improving STEM participation.

Changing what we do

In line with the three overarching key factors that we found shaped young people's science identities and aspirations, we suggest the following changes in practice would be beneficial: focus on **building science capital,** rather than just inspiring and informing young people about STEM; and identify and transform **educational gatekeeping practices** that restrict access or resources to certain groups of young people and **dominant representations of STEM** that reinforce the elitism of science.

Building science capital: building science capital in young people requires relatively long-term changes to core pedagogical practice and cannot be achieved solely through short-term and/or 'one-off' approaches. Key recommendations for building science capital include:

- Starting as early as possible (ideally from early in primary school).
- Moving away from single experience initiatives towards longer term, regular partnership work with young people.
- Focusing efforts and resources particularly on working with under-represented communities.
- Focus not only on the science content, but prioritise the mind-set through which science is taught, to better connect with and value the identities, knowledge and interests of all students.
- Using the principles of the science capital teaching approach (see http://bit.ly/SCTeach).
- Use the YESTEM compass to help you develop and apply a social justice mind set to policy-making and practice.[v]
- Working with others across the sector. Change will only happen when we work together towards the same aims (see http://bit.ly/PolicySciCap).

Identifying and transforming educational practices

- Focus on reforming the systems and practices that support and perpetuate notions of 'clever' science and 'masculine' science, especially gatekeeping practices that restrict access and/or resources for certain groups of young people in your setting.
- Lobby for changes to educational gatekeeping practices that restrict and narrow the pool of young people continuing with science/ STEM.
- Support increased resourcing for earlier, better quality, targeted careers provision for all young people.

Identifying and challenging dominant representations of STEM

- Audit and address how science and STEM are portrayed, represented and accessed in any given setting.
- Support a meaningful discourse among STEM educators and professionals to help identify, reflect on and challenge common practices and ideas about who does science and what gets recognised as 'being good at science'.
- Challenge notions of STEM as being 'hard', 'difficult' or for the 'clever' and the idea of there being a 'science brain'.

Impact

This research has achieved considerable impact on policy and practice across primary, secondary and informal science education sectors, both nationally and internationally. We were awarded the British Educational Research Association 2018 prize for Impact and Public Engagement, were finalists for the ESRC Societal Impact prize and were winners of the 2019 ESRC Panel's Choice award for impact.

v Archer, L., Godec, S., Calabrese Barton, A., Dawson, E., Mau, A., & Patel, U. (under review). Changing the field: A Bourdieusian analysis of educational practices that support equitable outcomes among minoritized youth on two informal science learning programmes.

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We hope that through the various project publications and outputs we have done justice to your rich experiences and views – and please know that your participation has made a real and measurable difference to how issues of science participation are both understood and addressed around the world.

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For further information on the ASPIRES research including the next phase of the project, ASPIRES 3 (age 20-23), please contact us at:

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ASPIRES 2
science and career aspirations: age 10-19

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The ASPIRES 2 project obtained ethical approval from the UCL Institute of Education Research Ethics Committee: REC 896 ASPIRES 2, Data Protection Registration Number Z6364106 2017 03 124